Claims

1. A multi-channel spectrum analyzer with a plane transmission diffraction grating, comprising:

   a. radiation collecting and delivery elements adapted to collect radiation simultaneously from a plurality of points of one or more sources of electromagnetic radiation and to deliver a spatial distribution of the radiation to a spectrum disperser;
   b. a spectrum disperser coupled to said radiation collecting and delivery elements for transmitting radiation, the spectrum disperser comprising
      i. an entry port,
      ii. a composite collimating lens for transforming divergent beams of polychromatic radiation emerging from the entry port into collimated polychromatic beams,
      iii. a transmission diffraction grating for transforming each collimated polychromatic beam from the first lens into a fan of collimated monochromatic beams, and
      iv. a composite focusing objective to transform each collimated monochromatic beam in each fan into a separate spot of radiation of a flat spectral image;
   c. a photodetector array placed in the plane of the flat spectral image for collecting radiation transmitted by the spectrum disperser and convert said radiation transmitted by the spectrum disperser into an electric signal.

2. The analyzer of claim 1, wherein a spectral working band of the spectrum disperser is within a spectral range of about 400nm to about 2500nm.

3. The analyzer of claim 1, wherein for an angular span δ of beams entering the objective with a spectral band whose shortest wavelength is λ_1 and longest wavelength is λ_2, the analyzer comprises a plane diffraction grating having a linear diffraction structure with period given by formula

$$d = \frac{\sqrt{(\lambda_2 - \lambda_1)^2 + (\lambda_2 + \lambda_1)^2 \cdot tg^2\left(\delta/4\right)}}{2 \cdot \sin\left(\delta/2\right)},$$

wherein, the normal to the surface of the grating creates with the axis of an incident polychromatic beam an angle α, independent on position of the working band in electromagnetic spectrum, and given by the formula

$$\alpha = atg\left[\frac{(r+1)}{(r-1)} \cdot tg\left(\frac{\delta}{4}\right)\right],$$

and wherein the fringes of the linear diffraction structure of the grating are perpendicular to the plane determined by the normal to the surface of the grating and the axis of the incident beam.

4. The analyzer of claim 1, wherein the radiation collection and deliver elements comprise a plurality of fiber optic radiation guides for transmitting collected radiation.

5. The analyzer of claim 4, wherein at least one radiation guide is coupled to at least one performance enhancing element, at one or more ends thereof.

6. The analyzer of claim 4, wherein at least one radiation guide is coupled to at least one radiation controlling element, at one or more ends thereof.

7. The analyzer of claim 4, wherein the plurality of radiation guides are coupled to a terminator element to arrange said guides along a straight line.

8. The analyzer of claim 1, further comprising calibration elements for producing a wavelength calibration signal.

9. The analyzer of claim 8, wherein said calibration elements are adapted to receive radiation from at least one wavelength calibration sources, and transmit said radiation within a single fiber.

10. The analyzer of claim 1, wherein said composite focusing objective comprises three lenses.

11. The analyzer of claim 10, wherein said composite focusing objective comprises two positive thin lenses and a negative thick lens, wherein the negative thick lens is positioned between the two positive thin lenses.

12. The analyzer of claim 11, wherein each positive thin lens is composed of a material having a refractive index between about 1.60 and about 1.62 and an Abbe number between about 58 and about 59, and wherein the negative thick lens is composed of a material having a refractive index between about 1.66 and about 1.68 and an Abbe number between about 31 and about 33.

13. The analyzer of claim 11, wherein the ratio of the axial thickness of the negative thick lens to the focal length of the composite focusing objective is between about 0.38 and about 0.42.

14. The analyzer of claim 11, wherein the ratio of the focal length of one positive thin lens to the focal length of the composite focusing objective is between about 0.45 and about 0.47.

15. The analyzer of claim 11, wherein the ratio of the focal length of the negative thick lens to the focal length of the composite focusing objective is between about –0.18 and about –0.20.

16. The analyzer of claim 11, wherein the ratio of the focal length of one positive thin lens to the focal length of the composite focusing objective is between about 0.39 and about 0.41.

17. The analyzer of claim 11, wherein the two positive thin lenses are composed of the same material, and wherein the negative thick lens is composed of a material different from the material of the two positive thin lenses.

18. The analyzer of claim 1, wherein the array is positioned within the analyzer to perform simultaneous registration of spectral composition of radiation emerging from every point of a slit.

19. Radiation collecting and delivery elements adapted to collect radiation simultaneously from a plurality of points of one or more sources of electromagnetic radiation and to deliver a spatial distribution of the radiation to a spectrum disperser, for use in the analyzer of claim 1.

20. A spectrum disperser adapted for coupling to radiation collecting and delivery elements for transmitting radiation, the spectrum disperser for use in the analyzer of claim 1, the spectrum disperser comprising
   i. an entry port,
   ii. a composite collimating lens for transforming divergent beams of polychromatic radiation emerging from the entry port into collimated polychromatic beams,
   iii. a transmission diffraction grating for transforming each collimated polychromatic beam from the first lens into a fan of collimated monochromatic beams, and
   iv. a composite focusing objective to transform each collimated monochromatic beam in each fan into a separate spot of radiation of a flat spectral image.